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Good morning, everyone. I would like to express my gratitude to the organizers of this conference for extending an invitation for me to participate.² The usual disclaimers apply: the following are my personal views, and they do not represent the views of the Central Bank of Mexico nor of its Board of Governors. Needless to say, I was pleased to receive the invitation to participate in this conference. However, it soon dawned upon me that it would present a unique challenge. Despite having a keen interest in academic research on financial markets, how could a policymaker like me, with a practitioner background, contribute to a group primarily comprised of researchers?

The answer to this question brought me fond memories from my experience as research assistant to Professor Shiller during my graduate studies. Shiller has a stellar reputation and has made seminal contributions to Economics and Finance, albeit, and I have to say, uncommon in our profession, he is humble and approachable. When he hired me, I was an MBA student –to set the record straight–, he said he would ask only two things from me. First, to read his essays and make sure they were readable and understandable. He must have thought: this guy is “conventional”, if he understands, most of the students will. Second, for me to challenge and make constructive criticism on his research, which I did, and I enjoyed, learned, and witnessed first-hand how the views of a researcher are well complemented with a practitioner’s perspective.

With this in mind, I have decided to proceed as follows: I will provide you with my perspective, which may be biased towards what a policymaker might read, on how some of the main ideas on the microstructure of financial markets have evolved. I am sure that you would be able to provide much input to complement and enhance my perspective. Next, I will try to outline some of the challenges that policymakers face in relation to financial markets. I will focus on the foreign exchange markets, underscoring two key issues. Finally, I will sketch some ideas that could potentially become research topics, or at least, highlight areas where further investigation would be beneficial for us practitioners.

In short, I would like to offer some ideas from the frontlines of financial markets. Given my team’s role in implementing monetary and exchange rate policy, serving as a federal government’s financial agent, shaping financial regulation, and managing international reserves, I hope to provide you with a multifaceted perspective.

¹ As prepared for delivery.

² I also thank Santiago García Verdú, who provided valuable inputs and comments for this document.

I would like to begin by very briefly discussing the literature that provided the foundations for today's analysis of market microstructure, which has helped us first, to conceptually understand how disperse information feeds into financial markets, how this has an impact on asset prices, and how those prices, in turn, convey such information back to agents. Second, by better understanding how financial markets fail –deviating from the efficient market hypothesis– and, thus, how they can be designed best to facilitate the exchange of financial assets.

What I consider to be one of the first significant papers in the field of finance. I recognize that this may not align with the expectations of portfolio managers, as it is not [Markowitz's \(1952\)](#) paper.³ Nothing personal, in fact, I am a portfolio manager.

[Hayek's \(1945\)](#) paper is foundational for our understanding on how information –used to solve society's economic problems– is dispersed, and how a market can be thought of as a mechanism for collecting and conveying such information through prices without anyone having full knowledge of the economy. This is done potentially in an imperfect way. One could argue that this paper was seminal for financial market microstructure.

There are some ironies about this paper. Let me highlight the following one:⁴ It went largely unnoticed for many years.⁵ While Hayek's work was ultimately recognized, it took him some years to secure an academic position, following the publication of what is probably his *magnum opus*. Perhaps, his work was not considered mainstream at the time. More likely, I think, his research was way ahead of his time. In any case, many years after its publication but a few years prior to Hayek's trip to Stockholm, two seminal papers were published:

First, [Fama \(1970\)](#) formalized the efficient market hypothesis (EMH), a central concept in modern financial theory, which has influenced many, if not all, areas of finance. While the EMH faces a joint hypothesis testing problem in practice –a less well-known issue among practitioners and the financial press– it is a modelling device that goes far, perhaps the farthest, in explaining asset price dynamics.

That said, it is worth mentioning that, as paraphrased from Fischer Black, financial markets appear to be more efficient from the banks of the Charles than from those of the Hudson. Professor Black was referring to the Charles River in Boston, where MIT is located, and where he spent some years. While the other reference is to the Hudson River in NY, next to where Wall Street is located, where he also worked. I tend to agree with him, efficiency is easy to test in academia, but not so much in practice.

This takes me to [Akerlof's \(1970\)](#) paper. It established the foundation for further investigation into market dynamics where asymmetric information is crucial, which is prevalent in financial

³ Markowitz's thesis on portfolio selection was certainly not considered mainstream at the time.

⁴ In addition, it was published in the same month that the Second World War came to an end, a conflict that partly involved a war of ideas between the best way of organizing an economy having on one end of the spectrum central planning and on the other market economies. Had it been published a few decades earlier, then it might have influenced the decision process of government officials and prevented the implementation of some economic systems that have repeatedly proven unsuccessful. That said, when I think about [Keynes' The economic consequences of the Peace](#), in which his warning was ignored, I see my initial view as wishful thinking. In this book, Keynes criticized the reparations imposed on Germany in the Paris Treaty and argue that they would create fertile ground for extremist movements.

⁵ This seems to be the initial fate of other important papers: [Bachelier's \(1900\)](#) paper comes to mind as well.

markets where investors have varying levels of information. While his narrative was based on the used cars market, similar considerations could be applied to “lemon” assets, if you allow me to use the term. A prominent example were the subprime securities prior to 2008.⁶

Alongside the two initial papers, a decade later, [Grossman and Stiglitz \(1980\)](#) challenged the notion of efficient markets and, to some extent, crashed the EMH party. They highlighted that, in accordance with the EMH, prices should reflect all available information, thereby eliminating any incentive for investors to seek further insights. Grossman and Stiglitz provided a framework for a more nuanced understanding of market efficiency, recognizing that prices reflect a subset of all available information.

Fast forward fifteen years, as a prominent contribution, [Kyle's \(1995\)](#) paper was published. His primary assertion is that prices in financial markets reflect not only public information but also private information held by so-called informed traders. Their trading activity provides insight into their information, albeit imperfectly, to the other traders, which in his paper are known as uninformed.

There has been, of course, significant progress since then, and I have barely scratched the surface of the evolution of these ideas. Ideas which in fact are taken into practice at Banco de México. The EMH is at the core of our Strategic Asset Allocation process for the investment of the international reserve portfolio. We extract expected returns from market prices (yield curves, option prices), as we believe it is a very objective alternative to build a long-term theoretical portfolio. But the shortcomings of the EMH lead us to adjust the information for biases that are present in market prices and to deviate tactically, through our Tactical Asset Allocation when we deem convenient.

Therefore, I would like to conclude the first section of my intervention by outlining some key takeaways. While financial markets are quite effective at collecting and conveying information, it is worth noting that there is still a substantial amount of asymmetric information or, more generally, financial frictions, that permeate financial markets. It might be the case that participants have access to private information. Thus, certain data –other than prices– can also be informative. At times, useful pieces of information will have to be inferred from “raw” data, some of which may be costly to acquire. As a case in point, I cannot emphasize enough how relevant is for a central bank to generate high quality market information to support optimal decision-making and, in most cases, also make such information publicly available. All in all, while there has been much progress made in the study of financial markets under *ideal conditions*, there is much work to be done in those cases in which financial markets fail to have those ideal conditions. This is largely what market microstructure studies.

Allow me then move on and focus on FX markets; in particular, on two important themes, one that has implications (pre-hedging) between counterparties (I'll take advantage of my

⁶ Closely related to this, a couple of years later, [Lucas \(1972\)](#) introduced a foundational change in macroeconomic thinking, reconciling short- and long-run views of monetary policy based on an information problem. One could argue that this led to the development of models that consider information and expectations as central elements. In his model, it was essential for each islander to distinguish between changes in relative demand and inflation shocks. Similarly, it is fair to say that those responsible for setting policy and investing need to identify and assess shocks on a daily basis. In some cases, this is done without the benefit of a model. Of course, [Muth \(1961\)](#) paper on Rational Expectations was central to their development.

participation in the GFXC on this issue), and the other that has recently proven to have financial stability implications (carry trade). (And I'll use my role of market participant and financial authority to elaborate on this).

Pre-hedging. For the benefit of everyone, pre-hedging is the management of the risk associated with one or more anticipated client orders, designed to benefit the client in connection with such orders and any resulting transactions.⁷ The key issue in this case is the presence of asymmetric information; thus, in some sense, Akerlof and others keep striking back. In essence, if clients and dealers had had common information, it would have had a minimal impact on their relationship.

Suppose that a client instructs a dealer to place a substantial FX order at a specific time later in the day. The dealer has now gained access to information that he could use to his advantage or that of a third client. To be more specific, the dealer could potentially exploit the private information provided by his client for personal gain, either by trading for its own account or for that of a third client, taking advantage of such information. This could result in a loss for the original client.

In each case, whether the dealer omits or conducts pre-hedging, there is the possibility of things going south for the client and/or the dealer. Thus, it seems reasonable to conjecture that a solution to pre-hedging must be some sort of rule under uncertainty that only works *on average*. It should be noted that there are potential scenarios in which the client, the dealer, or even both may incur in losses.

In any case, to the best of my knowledge, there is no known (second-best) solution to mitigate the problem inherent in the implementation of pre-hedging. A further disadvantage is that its implementation may be perceived as front-running, which is considered illegal, and that omitting it altogether may result in a loss for the original client.⁸

This is, in my view, a compelling illustration of an open issue in financial market microstructure. Thus, any ideas on how to mitigate the unintended consequences of pre-hedging would be much welcome, as it is a contentious discussion in FX markets (IOSCO is taking a look at this issue as we speak). From the perspective of this conference, the only drawback of this case is that I think it does not generally have financial stability implications.

I will now shift focus to a more relevant, at least from the perspective of this conference, though perhaps not entirely novel topic: the celebrated carry trade. I will discuss some of the microstructure aspects of the carry trade and its implications in terms of market volatility and, more importantly, financial stability, as well as some possible policy responses.

There are several aspects that policy makers and authorities should be aware of. First, the size of the position is challenging to assess; particularly, in real time. On a given point in time, there are ballpark figures available, but they tend to differ. Other factors affecting its size are: the liquidity in the funding market, the liquidity in the asset market, their volatility, and the extent of

⁷ Global FX Code, Principle 11.

⁸ [Muhle-Karbe and Oomen \(2023\)](#) propose that the client announces an incoming order **but not reveal the exact time** in which the order would be confirmed.

time the interest rate differential has driven investors' attention, among other ones.

Second, it is important to consider the degree of homogeneity among investors holding a position in the carry trade. Specifically, homogeneity in how investors react to global shocks. The opposite of this is more generally referred to as having a resilient investor base. Ideally, one would like to have heterogeneous investors in that they respond differently to global shocks so their responses tend to offset each other.

Third, the degree of capital and margin restrictions that investors must navigate. It is crucial to consider the potential impact of a shock on investors with limited flexibility (i.e., binding restrictions), and a pressing need to unwind their positions. After a shock, they may find themselves in violation of regulatory or risk management restrictions.

Fourth, the responsiveness or sensitivity of asset prices to changes in global investor positions. This pertains to the depth of financial markets in which global investors have a presence, their liquidity, and the willingness of other investors to assume the positions previously held by global investors.

The fifth element is the type of financial institutions holding the carry trade positions. For instance, multi-strategy hedge funds might be more prone to amplify initial shocks, as some managers within those hedge funds could change their positions in financial markets unrelated to the carry positions themselves.⁹ In this context, the recent paper by [Yu An and Amy Huber \(2024\)](#), which measures the price response to trading demand shocks to determine cross-elasticity between currencies and across different asset markets, can be useful to policy makers. In particular, -to assess the financial stability implications of its monetary policy decision- and -to assess the possible need of responding to the unravelling of carry trade positions.

The sixth element is the extent to which carry trade positions are funded in various currencies and invested in different asset markets. It is worth underscoring that while diversified funding and investment are sensible from an individual point of view, such positions could lead to more contagion between assets classes if a global shock materialize. (On this point, the unwinding of carry trades last August, had an impact not only on the JPY, but also on Malaysian ringgit and Swedish krone).

The seventh element is the agent-principal relationship between portfolio managers and their clients. As clients are unable to observe the effort put into by portfolio managers, they need a mechanism to mitigate it. Comparing them against their peers is one such mechanism.

Accordingly, the eight element is the extent to which portfolio managers are concerned with the performance of their peers. As you know, game theory is a fundamental tool for understanding how agents interact with each other and respond to information, in this case, regarding their peers' investment decisions.

This leads to a ninth element: the strategic interaction between portfolio managers. Indeed, the interaction between portfolio managers may potentially give rise to herd-like dynamics, which could occur through a variety of mechanisms or even a combination of them. For instance, some

⁹ In contrast, for example, macro hedge funds, which tend to base their decisions on macro fundamentals, should be less prone to do so.

investors may believe that a subset of them possesses private information. Some may assume that there is a group of investors with superior ability, and want to avoid being identified as an inferior asset manager. One could think of managers of different unobserved types.¹⁰

The crux of the matter is that portfolios managers might end up taking decisions not based on economic fundamentals, but rather based on their peers' decisions, potentially leading to bad equilibria.

Global investors make their decisions based on a wide range of factors, including market prices, private information, and other relevant data, including peer behavior. Understanding these elements is crucial for policy makers. More generally, the unwinding of carry trade positions may present a number of complexities. In the event of an adverse shock that erodes the profitability of carry trade positions, the resulting capital and margin requirements may be breached, prompting fire sales and subsequent declines in asset prices. In this context, the paper by Hillary Stein and co-authors ([Barbiero et al., 2024](#)) that examines the relation between dealer risk limit and currency movements can be useful, as it could shed light on how the breaching of risk limits affects exchange dynamics, a useful metric for policy makers no doubt.

It should be emphasized that in practice, the unwinding of carry trades is more likely to be driven by an increase in FX volatility, an appreciation of the funding FX, and/or a depreciation of the invested FX or investment asset, than by changes in the interest rate differential.

The larger the position in a carry trade, the more homogeneous the investors, the less liquidity in the asset market, the larger the drop in asset prices, and so forth will amplify the adjustments in related financial markets.

It could well be that the funding market may be less inclined to provide additional capital to support the carry trade position. This may be due to investors not meeting the requirements. This may also be due to the presence of asymmetric information. Some lenders may be willing to extend credit, but without sufficient information about the financial health of *individual* potential borrowers, they may choose to refrain from doing so in general.

This could result in depreciation pressures on the exchange rate associated with the asset market and appreciation pressures on the exchange rate associated with the funding market, leading to heightened FX volatility. In effect, recently, there were times in which the exchange rates were mirror images of each other.¹¹ (Like the JPY and MXN in early August).

The recent turbulent unwinding of carry trade positions, such as those funded in the Japanese markets, shares common aspects with other financial stress periods. For instance, the so-called *taper tantrum* episode in July 2013 was preceded by a prolonged period of low interest rates in the United States. As another example, the mini-budget crisis in September 2022 in the UK resulted in a critical mass of *homogeneous* pension funds facing binding restrictions and experiencing long-

¹⁰ Moreover, it is possible that some noise traders could be exploited by more informed investors ([De Long et al. 1990](#)). There is the possibility of informational cascades ([Welch, 1992](#)). In this setting, investors may ultimately disregard their own private information based on the actions of others.

¹¹ In light of this, it should be evident that not only investors engage in strategic interactions ([Morris and Shin, 2001](#)), but there is also the possibility of liquidity spirals. These are bidirectional loops between adverse liquidity shocks in the funding market and the asset market ([Brunnermeier and Pedersen, 2009](#)).

term interest rate shocks. One common factor is that the positions grew significantly over the years, many of which were leveraged and crowded, and once a shock occurred, all investors wanted to unwind their positions in a matter of days.¹²

All this leads to a very important set of questions. If there are herd-like dynamics between portfolio managers, their decisions could have significant impact on asset prices, beyond exchange rates. For instance, in Mexico, an important portion of these asset managers are nonresident bondholders. Thus, what is the best policy response in FX and bond markets? When and how should a central bank act as a liquidity provider of last resort? A market maker of last resort?

In the case of Mexico, government bond supply has increased significantly and the portion of non-resident bondholders has decreased from 32% to 14% since 2019. The residents have absorbed the bonds sold by the non-residents. There are then further questions. What is the absorption capacity of the local investors? How does one go about measuring this capacity? How is the debt issuance capacity of the Mexican government affected? And perhaps more importantly, from this conference's perspective, how is financial stability affected? I will not touch on the fixed-income market microstructure because of time constraint, but it is a field on its own.

By way of conclusion, there are a number of policy challenges that require our attention. Let me begin by commenting on the asset market. This is, of course, the market in which portfolio managers invest in. The first policy challenge is to determine how to assess underlying risks. In this case, a distinctive aspect is that risks may accumulate over an extended period without clear indications of this occurring. In some cases, as risks accumulate, the familiar risk measures may even move towards indicating less risk.

In some cases, less measured risk might mean more underlying risk.¹³ Paraphrasing [Andrew Crockett \(2000\)](#): *"the received wisdom is that risk increases in recessions and falls in booms. In contrast, it may be more helpful to think of risk as increasing during upswings, as financial imbalances build up, and materializing in recessions."*

There are a number of questions that require further investigation. What measures can the recipient economies take in advance to—in some way—prepare for such capital flows? (*ex ante*) What measures could the recipient economies take to address the outflows (*ex post*)? Is there a case for the economy funding the carry trade positions to address financial stability concerns overseas? (*ex ante* and *ex post*). This is, at best, unconvincing.

Firstly, central banks, most recently the Bank of Japan, do not have a mandate regarding financial stability beyond its borders. In the event of global shocks with an adverse impact within Japan, its central bank may become concerned. One could posit that the volatility in Japanese financial markets back in early August this year partly explains the Bank of Japan announcement a few

¹² This is akin to a fire in a movie theater. Everyone got in order and calmly to the movie theater, but when the alarm sets off, they all head for the exits, over-crowding ones. In our terms, similar to creating one-sided markets.

¹³ Related to this point is the microstructure issues that the VIX index have presented recently. In early August, the VIX index saw a spike, while fundamentals behaved well. As the VIX is based on quotes instead of actual trades, both dealers' quote-setting behavior, and the widening of bid-ask spreads contributed to its spike ([Todorov and Vlikov, 2024](#)). A related challenge is that the VIX index is extensively used as an input for risk management and early alert systems.

days after to calm markets in regards to its pace of monetary policy normalization.

Another possibility is an appeal for international coordination and cooperation. This presents the typical challenges associated with the provision of a global public good. In essence, global financial stability could be partly supported through some level of international cooperation, which, in general, is a fragile equilibrium.

This mechanism illustrates two key points. First, market microstructure can have a significant impact on financial stability, which is a key focus of this conference. Second, research, your research, could provide further insights in areas where there is still a need for greater clarity.

A central bank may employ certain policy tools to address unwarranted FX volatility, including FX interventions. There might also be contagion to other markets, including potential market disruptions in the local bond market. In this context, the central bank might have to act as a liquidity provider of last resort, or a market maker of last resort, to avoid the deterioration of a market equilibrium.

However, a more comprehensive policy solution would be to enhance the local market microstructure, which often requires significant investments of time and resources. This is the area in which we have concentrated some our efforts over the past few years, contributing – from our frontline– towards the development of local financial markets. Their development entails the level of competition in various financial markets, an aspect studied in the papers presented by Patrick Coen and coauthors ([Coen et al. 2024](#)), Hannes Halder ([Halder 2024](#)), and Assa Cohen ([Cohen, 2024](#)), respectively, in different settings.

I have learned through the years, and this might sound hackneyed, that there are no silver bullets for financial market development. It takes many elements to develop them, thus thinking about the financial sector as an ecosystem might be useful. In effect, a robust development policy takes time, effort, and in many cases, dealing with entrenched interests, for which one needs more than good luck.

And I also have the conviction that, when dedicated researchers such as yourselves, work together with experienced practitioners and challenge each other views, the outcome is far better, whether it is a research document, an investment strategy or a policy action. Hopefully all of them leading to more stable and resilient financial markets. I think this is a good point to stop, and this should not be understood as if I do not have many more challenges to point out. Thank you very much for your attention. I wish you all the success with the conference.